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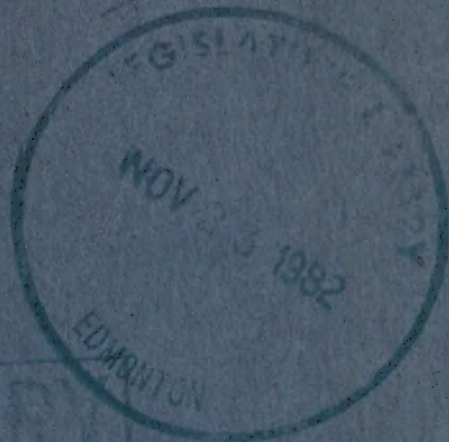
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Drainage Cost Benefit Study of the Eastern Irrigation District.



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ALBERTA
DEPARTMENT OF AGRICULTURE

IRRIGATION STUDIES-1966
VOLUME II



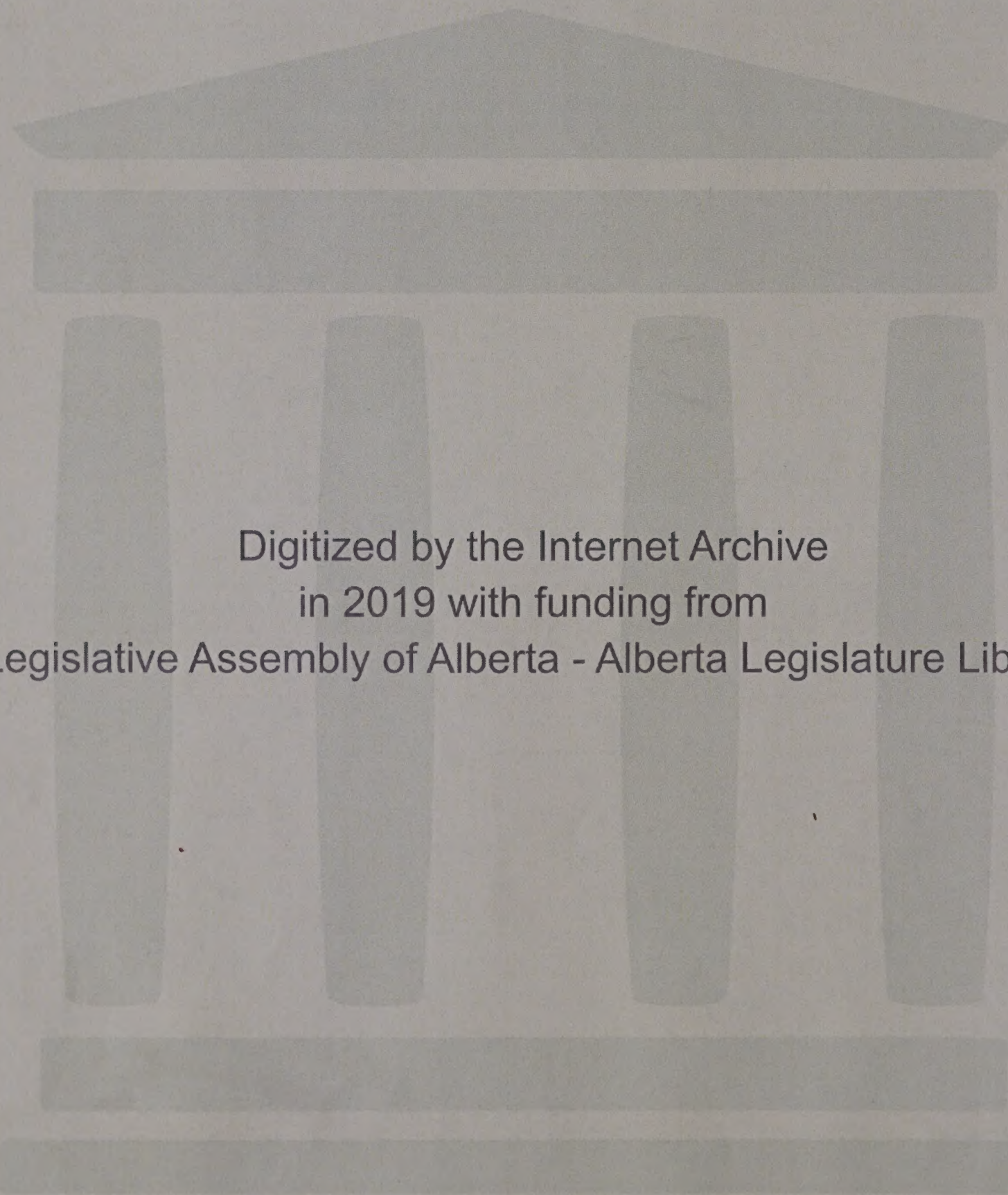
DRAINAGE COST-BENEFIT STUDY OF THE EASTERN IRRIGATION DISTRICT

L.D.M. SADLER, M.A. CAMERON, ET AL.

LETHBRIDGE, ALBERTA
FEBRUARY 1, 1966

PREPARED BY
COLONIZATION, ECONOMICS, AND
WATER RESOURCES BRANCHES

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ALBERTA

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Department of Agriculture

Alberta Irrigation Studies - 1966

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DRAINAGE COST - BENEFIT STUDY

OF THE

EASTERN IRRIGATION DISTRICT

LIST OF AUTHORS

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LETHBRIDGE, ALBERTA

February 1, 1966

PREPARED BY:

Colonization, Economics, and
Water Resources Branches

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TERMS OF REFERENCE

DRAINAGE STUDY OF THE EASTERN IRRIGATION DISTRICT FOR IRRIGATION POLICY COMMITTEE

Part I. Colonization and Water Resources Branch

Objective: To delineate problems and remedial works associated with:

(1) Surface Drainage

(2) Internal Drainage

Procedure: Four study areas at Rainier, Tilley, Patricia and Rosemary will be used. The results will be expanded to the entire irrigated portion of the Eastern Irrigation District.

a. Investigations: Studies will take the form of detailed deep soil borings, limited visual inspections, surface sampling of selected sites and limited engineering surveys.

b. Construction Costs: The resulting data will be a basis for estimates of necessary

- (1) Canal lining or deepening
- (2) Interception drainage
- (3) Outlet Drainage
 - a. Rehabilitation of existing drains.
 - b. New drainage works

c. Maintenance and Operation: Estimates of operation and maintenance costs of those works associated with drainage problems will take the following form:

1. The existing drainage works

2. Revamped and proposed drainage works

3. Additional costs of maintaining proposed lined and/or deepened sections of canals.

d. The portion of capital works that require replacement and the corresponding life expectancy of such works.

PART II. Economics and Colonization Branch

Objective: To estimate the cost-benefit relationship of drainage and other remedial measures within the Eastern Irrigation District.

Procedure: Study the results of drainage and lining projects implemented in adjacent irrigated areas to determine the pattern that exists relative to:

1. degree of improvement in agricultural production attained
2. the time lag from initiation to the date money income is derived
3. An assessment of the degree of recovery of production in comparison to the normal production on non-affected areas.

Estimate the present rotation and production on the affected areas in the drainage basins studied in comparison to normal production for the basin.

Employ the cost of construction and operation and maintenance costs provided by the Colonization and Water Resources portion of the study to evaluate the proposals in terms of the economic benefits that may be derived at the farm level by increased returns. (The terms of reference do not appear to cover the areas of capital finance (long and short term), benefits that may be derived by the Irrigation District, County, non-agricultural segments of the economy or to society resulting from the maintenance of production and conservation of natural resources).

Target Dates: December 1, 1965, Data Collection and Rough Outline Complete.

January 1, 1966, First Draft.

February 1, 1966, Final Draft Complete.

ABSTRACT

Drainage and reclamation of the Eastern Irrigation District, both from physical and economic standpoints, were studied. Four study areas, chosen for variability and topography, soils geology and degree of farming intensity, were assumed to represent the overall project. Field and office investigations were the basis for estimating problem area extent and costs of alleviation by drainage and canal lining. As background material, recent drainage experience in the eastern division of the St. Mary and Milk Rivers Development was analyzed.

Total construction costs were estimated at \$8,648,120.00 for the Eastern Irrigation District and maintenance and replacement costs of drainage and lining works at \$554,001.00 per annum. Net returns considered in the study indicate a total of \$1,374,539.00 accruing to agricultural production and \$110,375.00 to the project as a result of drainage construction and canal lining.

EASTERN IRRIGATION DISTRICT DRAINAGE STUDY

General Report

INTRODUCTION

In 1963, A.R.D.A. agreements were signed permitting a multiphase study of irrigation in Alberta. Preliminary reports on operation, maintenance and rehabilitation requirements for the Eastern Irrigation District were completed in the summer of 1965. In September of 1965, the Colonization, Water Resources and Economics Branches of the Alberta Department of Agriculture were instructed to carry out a complete drainage study related to problem areas of the Eastern Irrigation District: this latter report to be in a final form by February 1, 1966.

Terms of reference for the study were submitted and approved by the Irrigation Policy Committee in November, 1965. These embody considerations of surface and subsurface drainage and canal lining construction and maintenance and the associated economic considerations.

In order to complete the study in the limited time available, it was decided to use representative areas as a basis for projection of overall Eastern Irrigation District considerations. The criteria used in the selection of representative areas included variants such as soils, geology, topography, extent of problems and geographical location. From the outcome of the study, it is obvious that a wide range of conditions prevail in the project.

INVESTIGATIONAL PROCEDURES AND PROGRAMMES

The programme of investigations is described herein under the main headings of 1) Soils, drainage and groundwater, 2) Construction and maintenance, and 3) Economics. Summaries of investigational field work are shown in Table 1.

1) Soils, Drainage and Groundwater

In the early spring of 1965 twenty deep holes were contract drilled in the Eastern Irrigation District to obtain preliminary information for anticipated detailed investigations. When the current study began in September, 1965, the information proved valuable.

Holes were drilled and logged on a mile grid basis and water table recording wells established to monitor ground water fluctuations and obtain samples for periodic salt analysis. As well, more detailed drilling was done on several of the main laterals in each basin. In all cases soil samples were obtained at the surface and the glacial till contact. Maximum drilling depth was 20 feet. Thirdly, detailed surface soil sampling was carried out on several parcels in each basin to establish the severity of typical salt and seepage problems.

All ground water installations were referenced as to location and elevation. In the process, temporary bench marks were established at one-half mile intervals for future anticipated use.

Professional staff made several inspection trips into each area to supplement field information.

Water table installations are being monitored on a twice monthly schedule.

Office inspections of air photos, Eastern Irrigation District classification plans and topography sheets completed the data gathering process.

To arrive at the summary shown on Table 4, the following procedure was used.

All areas presently considered affected by seepage, high ground water and periodic flooding were estimated. Secondly, those areas presently classed non-irrigable by the Eastern Irrigation District due to the same causes were tabulated. An estimate of the difference subtracted from the Eastern Irrigation District classified acreage gave a basic acreage figure. The acreage shown in line 3 of Table 4 is this latter figure increased by the amount that complete drainage and lining, etc. would reclaim. For example, when referring to the Rosemary area, total problem area is 1,970 acres or 16% of what would be productive irrigable land following drainage and reclamation.

Portions of lining and interception drainage were estimated on the basis of previous soil

surveys, (Canada Department of Agriculture), current drilling, visual inspections and office interpretation. Estimated costs for the Rosemary, Patricia, South Bantry and Rainier drainage basins are included in Table 5.

During the field inspections, extensive portions of road borrow pit were noted to contain cattails which is an indication of poor drainage. As a result, estimates are included for borrow pit improvement.

2) Outlet Drainage Estimates of Construction, Maintenance and Replacement

An estimate of proposed construction costs was determined by field profiles and field inspections. Topography sheets and aerial photographs were studied in the office to locate an outlet for each irrigated parcel. An average depth of 6.0' was used for drainage design purposes throughout the area. Culverts and drop structures were also estimated on this basis and a total estimate arrived at for each study area.

Operation and maintenance costs were estimated by using standard known rates for cleaning equipment and machines and from previous experience. These unit rates were used to derive a total figure for annual operation and maintenance in dollars per mile per year. By applying this to the total number of miles of drains in each area, the total annual operation and maintenance costs were determined.

Replacement costs are calculated on a 30 year basis for culverts and 50 year basis for structures, lining and interceptor drains.

TABLE I
SUMMARY OF FIELD INVESTIGATIONAL WORK

	<u>Rosemary</u>	<u>South Bantry</u>	<u>Patricia</u>	<u>Rainier</u>	<u>Total</u>
Water Table Wells (Read 3 times each)	37	36	30	44	147
No. of Readings	111	108	90	132	441
10' holes drilled	7	12	6	72	79
15' holes drilled	131	94	92	101	418
20' holes drilled	20	18	14	23	75
Total holes drilled	158	124	112	196	590
No. feet drilled	2435	1890	1720	2695	8740
Soil Samples					
No. of Surface Samples	408	130	172	243	953
No. of Subsurface Samples	93	23	50	103	269
Total Samples	501	153	222	346	1222
Survey	55	53	45	68	221
No. miles of level for purposes of W.T. well elevations and establishment of T.B.M. ^s					

3) Economic Analysis

The drainage systems constructed in the St. Mary and Milk Rivers Development, commencing in 1961, were evaluated to determine the degree of recovery in production that was achieved. A comparison between the production at the time drainage was installed and the production achieved in 1965 was used to obtain an assessment of the success of drainage. From this assessment, it was found that in the average time span of four years, a normal cropping pattern for the districts had been achieved on 94% of the affected acreage. Production on this acreage was comparable to that on the non-affected

areas on the farms involved. This report provided the basis for the estimation that production can be restored to 90% of normal in the Eastern Irrigation District within four years of drainage and lining construction.

The crop reports compiled by the Eastern Irrigation District Management were obtained for the four study areas involved, as well as for the entire Eastern Irrigation District for the years 1962, 1963, and 1964. This information was used to establish the normal cropping patterns and the estimated returns per cultivated irrigated acre that are shown for the various drainage systems projected in this report.

An assessment of the variable costs per acre for agricultural production was made by averaging the variable costs per cultivated acre as found in the Irrigated District Farm Business Analysis reports for 1962, 1963, and 1964 for Bow Island, Grassy Lake, Medicine Hat and the Bow River Development districts. It was assumed that the cropping patterns for these areas were comparable to the Eastern Irrigation District cropping patterns. The average variable cost per cultivated acre from these reports was \$7.65. Costs have increased during this period, so the writer estimated at \$10.00 per cultivated acre charge in this report to compensate for these increases in costs and for the projection.

The prices used in this report were estimated on the basis of information received in the Eastern Irrigation District for the years studied and adjusted where necessary to take into account present price trends.

Other costs such as water rate and increased taxes for irrigated land were estimated on the basis of district experience. The interest rate used was 5% in all cases.

The Cost-Benefit Analysis of drainage is analyzed from two aspects: (1) The effect that the proposed drainage system would have on the operation of the Eastern Irrigation District in relation to costs and returns. (2) The effect upon the agricultural production

of the District. An analysis was made of the added costs of production that could be expected by farming the land that will be reclaimed by drainage in comparison to the additional agricultural revenue that will result.

RELEVANT INFORMATION

1) Land Development

In order to present a picture of some of the tangible progress in the study basins related to farmer financed self improvement, resumes of land levelling were prepared (Tables 2 and 3). The figures show that particularly in the Rosemary and Rainier areas the amount of farm development by levelling has been spectacular. These acreages are only for those areas in which the Land Development Service was involved and do not include levelling and designs by individual developers prior to 1957. In at least some cases, development would have been better facilitated, had outlet drainage and ground-water control been more comprehensive.

TABLE 2

SUMMARY OF LAND LEVELLING - FOUR STUDY BASINS

1957 - 65 Inclusive

	<u>Area (ac.)</u>	<u>Total Yardage</u>	<u>Est. Cost/Ac.</u>	<u>% of Irrig. Class. Acreage</u>
Rosemary	2,202	663,165	\$44.10	21%
South Bantry	343	121,572	\$51.50	3%
Patricia	57	15,097	\$39.80	1%
Rainier	<u>1,281</u>	<u>495,112</u>	<u>\$56.50</u>	<u>11%</u>
Total	3,883	1,294,946	\$47.90	

TABLE 3

SUMMARY OF LAND LEVELLING, EASTERN IRRIGATION DISTRICT

1957 - 65 Inclusive

Year	Acres	Ave. Cost Per Acre	Total Cost (Approx)	Total Yardage
1957	107.0	16.41	1,756	23,159
1958	556.0	32.35	17,971	126,415
1959	608.6	35.4	21,553	131,721
1960	1,114.8	34.25	38,187	259,488
1961	973.0	42.3	41,158	294,453
1962	1,519.0	42.8	64,560	430,398
1963	2,084.0	47.4	98,838	684,338
1964	3,785.7	49.86	188,727	1,258,185
1965	<u>2,859.3</u>	<u>57.23</u>	<u>162,843</u>	<u>1,090,899</u>
Total	13,607			

ANALYSIS OF DATA

1) Soils, Drainage, Groundwater and Construction Costs

Table 4 indicates that with minor exceptions, areas similar to the South Bantry Basin could be reclaimed and protected from future damage at low per acre cost. This is due to the nature of soils and topography. Soil geology is such that underlying impervious materials occur at a shallow depth below relatively salt free soils. Thus seepage is confined primarily to narrow zones adjacent and parallel to canals. This situation is somewhat shadowed by the fact that from a standpoint of desirability for irrigation, deep, uniform, medium textured soils are an advantage.

The Patricia Basin, on the other hand, is an example of non-uniform soil geology and poorer topography. Costs per acre based on the estimated original classification are quite high, however, it should be noted that 45% of this area is of a problem nature; thus the relative benefits to the area are higher than in the other three study areas.

In at least a few areas, when drainage and groundwater control have been installed, reclamation and special cultural procedures following project work will be required. Some "on the farm" drainage may be required, as well. This additional work is estimated at One Million dollars for the Eastern Irrigation District based on approximately \$50.00 per acre on one half of the salt and seepage affected acreage.

TABLE 4
SUMMARY OF CLASSIFICATION STATISTICS

	<u>Rosemary</u>	<u>Patricia</u>	<u>Rainier</u>	<u>S. Bantry</u>	<u>Entire E.I.D.</u>
E.I.D. Class. Irrig. (as per classification Print) (acres)	10,680	5,400	12,130	12,860	193,500
Reduced total due seepage and low (acres)	10,340	4,890	10,520	12,350	179,510
Est. E.I.D. Original Class. Irrig. (acres)	12,310	8,890	14,360	14,880	237,650
N.I. due to seepage and salts (acres)	1,150	3,560	3,370	1,910	47,070
N.I. due to low and depressional (acres)	820	440	470	620	11,070
% affected - based on Orig. Irrig. Class.	16%	45%	27%	17%	
Ultimate due to full development (acres)	14,790	10,510	18,000	18,340	290,410

TABLE 5

DRAINAGE AND LINING COST SUMMARY

	Rosemary	Patricia	Rainier	S. Bantry	Entire E.I.D. 1)
<u>Outlet Drainage</u>					
<u>Rehabilitation of existing outlet drains</u>					
a) Miles	32.0	27.0	39.7	29.3	603
b) Cost	\$176,660	\$150,490	\$207,640	\$121,010	\$3,089,780
c) Cost/orig.class.irrig.(acre)	\$14.35	\$17.42	\$14.46	\$8.13	\$13.00
<u>Construction of new outlet drains</u>					
a) Miles	9.4	9.3	6.5	7.0	152
b) Cost	\$66,420	\$63,900	\$42,310	\$36,590	\$985,730
c) Cost/orig.class. irrig. acre	\$5.40	\$7.19	\$2.95	\$2.46	\$4.15
<u>Interceptor Drainage</u>					
	Open & Tile	Open	Tile	Open	
a) Miles	5.9	10.0	6.8	16.2	183
b) Cost	\$61,800	\$24,700	\$109,000	\$51,000	\$1,161,370
c) Cost/orig. class. Irrig. acre	\$5.02	\$2.79	\$7.59	\$3.43	\$4.89
<u>Canal Lining or Deepening</u>					
a) Miles	15.1	30.3	41.0	21.2	507
b) Cost	\$95,630	\$176,900	\$274,000	\$124,000	\$3,159,180
c) Cost/orig. class. irrig. acre	\$7.77	\$19.90	\$19.08	\$8.33	\$13.29
<u>Borrow Pit Improvement</u>					
a) Cost	\$13,500	\$10,000	\$15,000	\$15,000	\$252,060
b) Cost/orig. class. irrig. acre	\$1.10	\$1.12	\$1.04	\$1.01	\$1.06
Total Cost	\$414,010	\$425,990	\$647,950	\$347,600	\$8,648,120
Total Cost/orig. class. irrig. acre	\$33.63	\$48.42	\$45.12	\$23.36	\$36.39
Total Cost/Present Class. Irrig. acre	\$38.76	\$78.89	\$53.42	\$27.03	\$44.69
Total Cost of Inter. & lining/ seepage & salt affected acre	\$137.00	\$56.50	\$113.60	\$91.50	\$91.50

1) Calculated by a weighed average method.

TABLE 6

ESTIMATED ANNUAL COSTS OF OPERATION, MAINTENANCE AND STRUCTURE REPLACEMENT

	Rosemary	Patricia	Rainier	S. Bantry	Entire E.I.D.
Annual Operation & Maintenance costs of outlet drains by dragline	\$7,513	\$6,581	\$8,382	\$6,595	\$136,970
Annual Cost/Orig. Class. Irrig. acre	\$0.61	\$0.74	\$0.58	\$0.44	\$0.58
Annual Operation & Maintenance of Interceptor drains	\$370	\$1,000	\$180	\$1,620	\$14,900
Annual Cost/Orig. Class. Irrig. acre	\$0.03	\$0.11	\$0.01	\$0.11	\$0.06
Replacement of Culverts and Structures - annual charge	\$2,135	\$1,840	\$2,165	\$790	\$32,650
Annual Cost/Orig. Class. Irrig. acre	\$0.17	\$0.21	\$0.15	\$0.05	\$0.14
Replacement of Interceptor drains, Annual charge	\$1,236	\$494	\$2,180	\$1,020	\$23,227
Annual Cost/Orig. Class. Irrig. acre	\$0.10	\$0.06	\$0.15	\$0.07	\$0.10
Replacement of Canal Lining Annual charge	\$1,913	\$3,538	\$5,480	\$2,480	\$63,184
Annual Cost/Orig. Class. Irrig. acre	\$0.16	\$0.40	\$0.38	\$0.17	\$0.27
Annual Total Operation and Maintenance & replacement costs	\$13,167	\$13,453	\$18,387	\$12,505	\$270,931
Annual Cost/Orig. Class. Irrig. acre	\$1.07	\$1.51	\$1.28	\$0.84	\$1.15

2) Cost Benefit Analysis

The effect of the proposed drainage system for the Eastern Irrigation District is analyzed in Tables 7 and 8.

Table 7; The Cost - Benefit Relationship of Proposed Drainage analyzed the proposal from the standpoint of the effect it might have upon the management of the irrigation district. An estimate of the capital costs of development as provided by the Colonization Branch, Soils and Drainage Division, and the Water Resources Branch was used as the basis for these calculations. In addition to projecting the estimate for the entire district, a similar consideration was applied to the four drainage areas investigated. This provided a basis for comparing the effect of drainage under a number of different circumstances.

A. Capital Costs of Development

14

The total capital costs in this section of the Table were used to estimate the annual capital costs. Depreciation was calculated on the capital assets that deteriorate over a period of years, and therefore, must be replaced at the end of the estimated useful life. Culverts were depreciated on the basis of a useful life of thirty (30) years and drop structures and canal lining were depreciated on the basis of fifty (50) years of useful life. Interest was calculated at the rate of 5% on the average value of the capital items.

In total, the analysis is as follows:

Capital costs of development - \$8,648,120

Annual depreciation cost - \$119,061

Annual interest cost - \$283,070

B. Summary

The total annual costs of operation of the proposed drainage system were considered. Annual capital costs amount to \$402,131. Annual operation and maintenance of the system amounting to \$151,870 was added to arrive at the total annual cost of \$554,001.

The additional district revenue that can be derived by 44,150 extra acres added to the irrigable classification amounts to \$110,375 annually. This amount is \$443,626 short of covering the total annual costs, or on the basis of the total acreage estimated in the district after drainage (237,650 acres) would amount to \$1.86 per acre.

C. Comparison Based on Cash Costs (not including interest on capital)

A further analysis was made on the basis of annual cash costs and returns. The annual cash costs of operation, maintenance and replacement amount to \$270,931. The annual added revenue of \$110,375 indicates that cash income falls \$160,556 short of covering cash costs. When calculated on the estimated irrigable acres following drainage (237,650 acres) this deficit amounts to \$0.68 per acre.

TABLE 7

COST BENEFIT RELATIONSHIP OF PROPOSED DRAINAGE

E.I.D.

E.I.D. Classified Irrig. (per class. print) 193,500 acres
Classed N.I. 44,150 acres

A. CAPITAL COSTS OF DEVELOPMENT

Capital Cost	Depreciation	Interest	Capital Cost	Depreciation	Interest
Outlet Drainage - Renovations and New Construction					
Earthwork	\$ 17,840	\$140,035	\$159,940		
Culverts	\$ 14,810	\$ 13,375	\$ 35,400		
Drop Structures		\$ 18,495	\$ 47,740		
Total Costs - Outlet Drainage	\$ 32,650		\$ 213,080		
Interception Drainage	\$ 23,227	\$ 29,034	\$ 61,800		
Canal Lining or Deepening	\$ 63,184	\$ 78,980	\$ 95,630		
Borrow Pit Improvement		\$ 3,151	\$ 13,500		
Total	\$119,061	\$283,070	\$414,010		

B. SUMMARY

Annual Capital Costs - Depreciation	\$119,061
- Interest	\$283,070
(1) Total Annual Capital Costs	\$402,131
Annual Operation and Maintenance - Interceptors	\$ 14,900
- Drains	\$136,970
(2) Total Annual Operation and Maintenance	\$151,870
Total Annual Costs (1 + 2)	\$554,001
Estimated Additional Annual Revenue (44,150 acres @ \$2.50/ac.)	\$110,375
Total Costs not Covered by Additional Revenue	\$443,626
Amount of Costs not Covered per Est. E.I.D. Original Irrig. Acre	\$1.86

C. COMPARISON BASED ON CASH COSTS

Total Annual Cash Costs for Operation, Maintenance and Replacement (Annual Capital Cost of Depreciation)	\$270,931
Estimated Additional Annual Revenue Received	\$110,375
Operation, Maintenance and Depreciation Cash Cost not Covered	\$160,556
Rate per Est. Original Irrig. Acre Necessary to Cover Costs	\$0.68

TABLE 7

COST BENEFIT RELATIONSHIP OF PROPOSED DRAINAGE

PATRICIA

5,400 acres
3,490 acres

RAINIER

12,130 acres
2,230 acres

SOUTH BANTRY

12,860 acres
2,020 acres

Capital Cost	Depreciation	Interest	Capital Cost	Depreciation	Interest	Capital Cost	Depreciation	Interest	Capital Cost	Depreciation	Interest
\$136,950		\$ 7,997	\$163,680		\$ 6,847	\$133,870		\$ 8,184	\$133,870		\$ 8,184
\$ 21,615		\$ 885	\$ 32,804		\$ 541	\$ 23,730		\$ 820	\$ 23,730		\$ 820
\$ 55,825		\$ 1,194	\$ 53,466		\$ 1,396			\$ 1,337			\$ 1,337
\$214,390			\$219,950			\$157,600			\$157,600		
\$ 24,700		\$ 1,545	\$109,000		\$ 618	\$ 51,000		\$ 2,725	\$ 51,000		\$ 2,725
\$176,900		\$ 2,391	\$274,000		\$ 4,423	\$124,000		\$ 6,850	\$124,000		\$ 6,850
\$ 10,000		\$ 169	\$ 15,000		\$ 125	\$ 15,000		\$ 1,875	\$ 15,000		\$ 1,875
\$425,990		\$14,181	\$647,950		\$13,950	\$347,600		\$21,791	\$347,600		\$21,791
\$ 5,284											
\$ 5,284											
\$14,181											
\$19,465											
\$ 370											
\$ 7,513											
\$ 7,883											
\$27,348											
\$ 4,075											
\$23,273											
\$1.89											
\$13,167											
\$ 4,075											
\$ 9,092											
\$0.74											

\$4,290
\$11,850
\$16,140

\$ 1,620
\$ 6,595
\$ 8,215

\$24,355

\$ 5,050

\$19,305

\$1.30

\$12,505
\$ 5,050

\$ 7,455

\$0.50

Table 8; The Estimated Effect of the Proposed Drainage on Agricultural Net Return in the Eastern Irrigation District, presents an analysis of the estimated effects of drainage on agricultural production. The effect was analyzed for the entire Eastern Irrigation District as well as the four individual study areas previously considered. The purpose of the analysis of the individual basins provided a comparative estimate of the proposed drainage under different conditions.

The analysis was made on the basis of the fact that of the total acreage of 58,140 acres that can be returned to production, 44,150 acres are presently classified non-irrigable, and 13,990 acres are presently classed irrigable but non-productive. The charges of increased water rate and increased taxes apply to the 44,150 acre reclaimed. The increased variable costs of production apply to the entire acreage of 58,140 acres. Additional gross and net income expected was also based on the 58,140 acres to be returned to production.

A number of assumptions were made relative to the analysis. The first assumption, based on the review of drainage installed in the St. Mary and Milk Rivers Development was that after four years production will be 90% of the normal for the areas involved. No attempt has been made to measure the amount of recovery during the first, second and third years after drainage, as basis for such a comparison is not available. It would, however, appear that production would recover equally over the period. It was also necessary to recognize that the rate of return to production would vary with the area and with individual farming practices.

A further assumption made was the fact that the area reclaimed will be a small percentage of the acreage of each individual farm. For this reason, it was assumed that there will be no increase in farm overhead expenses as a result of adding the reclaimed acres to production at farm level.

The estimated increased costs of agricultural production in the Eastern Irrigation District as a result of farming the increased acreage is \$713,850. The gross value of the increased production derived four years after the installation is estimated at \$2,088,389 with an

TABLE 8

THE ESTIMATED EFFECT OF THE PROPOSED CONSTRUCTION
ON AGRICULTURAL NET RETURNS (E.I.D.)

	E.I.D.	ROSEMARY	PATRICIA	RAINIER	S. BANTRY
Estimated Acreage Returned to Production Presently Classed N.I.	44,150 acres	1,630 acres	3,490 acres	2,230 acres	2,020 acres
Estimated Acreage Returned to Production Presently Classed Irrigable	13,990 acres	340 acres	510 acres	1,610 acres	510 acres
Total Estimated Acreage Returned to Production	58,140 acres	1,970 acres	4,000 acres	3,840 acres	2,530 acres
ESTIMATED INCREASED COSTS OF AGRICULTURAL PRODUCTION					
Water Rate 44,150 @ \$2.50	\$110,375.00	\$ 4,075.00	\$ 8,725.00	\$ 5,575.00	\$ 5,050.00
Increased Taxes 44,150 @ \$0.50	\$ 22,075.00	\$ 815.00	\$ 1,745.00	\$ 1,115.00	\$ 1,010.00
Increased Variable Costs 58,140 @ \$10.00	\$581,400.00	\$19,700.00	\$40,000.00	\$38,400.00	\$25,300.00
Total Estimated Increased Costs	\$713,850.00	\$24,590.00	\$50,470.00	\$45,090.00	\$31,360.00
ESTIMATED VALUE OF INCREASED PRODUCTION 4 YEARS AFTER INSTALLATION OF DRAINAGE (Assume 90% Recovery)					
Additional Net Return Derived from Reclaimed Acreage	\$2,088,389.00	\$65,325.00	\$119,360.00	\$175,219.00	\$88,803.00
PER ACRE BASIS	\$1,374,539.00	\$40,735.00	\$68,890.00	\$130,129.00	\$57,443.00
Estimated Additional Gross Return Per Acre Reclaimed	\$35.92	\$33.16	\$29.84	\$45.63	\$35.10
Estimated Increased Costs Per acre Reclaimed	\$12.28	\$12.48	\$12.62	\$11.74	\$12.40
Estimated Additional Net Return Per Acre Reclaimed	\$23.64	\$20.68	\$17.22	\$33.89	\$22.70

increased net return of \$1,374,539 added to the present value of agricultural production in the district.

The estimates based on 58,140 acres reclaimed are \$35.92 per acre gross income, \$12.28 per acre production costs, and \$23.64 per acre net return.

In order that this study more closely relate to the summary and procedures employed in the University of Alberta Research Bulletin "The Economic Benefits and Costs of Irrigation in the Eastern Irrigation District of Alberta", a further analysis is employed. The various costs of rehabilitating, maintaining and operating the proposed drainage system over a 25 year period and a 100 year period are calculated as follows:

TABLE 9
AMORTIZED COSTS

Item	Capitalization	Economic Life	Annual Cost	
			25 years	100 years
Earthwork	\$2,800,690	100 years		141,107.56
Culverts	534,990	30 years		34,801.87
Drop Structures	739,830	50 years		40,525.48
Interception Drainage	1,161,370	50 years		63,616.06
Canal Lining and Deepening	3,159,180	50 years		173,049.58
Borrow Pit Improvement	252,060	100 years		12,699.57
Total Capital Cost	\$8,648,120		613,605.39	465,800.12
Add Operation and Maintenance Costs			151,870.00	151,870.00
			765,475.39	617,670.12

Procedure - Annual Costs of Capital Recovery were calculated using 5% interest charges and the useful life of the structures. For 25 years repayment period only the lump sum requires calculation.

Benefit-Cost Comparisons

The benefit - cost comparisons which follow are determined by using the procedures set forth by the University of Alberta Research Bulletin:

TABLE 10
BENEFIT - COST COMPARISONS

	<u>25 year Period</u>	<u>100 year Period</u>
(1) Total Direct Benefits	\$2,088,389	\$2,088,389
(2) Associated Costs	603,475	603,475
(3) Net Direct Benefits	1,484,914	1,484,914
(4) Project Costs	765,475	617,670
(5) Total Costs	1,368,950	1,221,145
(6) Net Project Benefits (1 - 5)	719,439	867,244
(7) Investment Required	8,648,120	8,648,120
(8) Total Capital Costs	613,605	465,800
(9) Total Non Capital Costs	755,345	755,345
(10) Net Return on Investment (1 - 9)	1,333,044	1,333,044
(11) % Return on Investment (10 ÷ 7)	15.4%	15.4%
(12) Total Benefit Cost Ratio (1 ÷ 5)	1.53	1.71
(13) Net Benefit Cost Ratio (3 ÷ 4)	1.94	2.40

The Value of the additional agricultural production attributable to drainage at \$2,088,389 and the associated production costs at \$603,475, gives a net direct benefit of \$1,484,914 annually. The annual costs of drainage, including capital costs and operation and maintenance costs are estimated at \$765,475 annually for 25 years or \$617,670 if considered over a 100 year period. The ratio of net project benefits to project costs is 1.94 to 1.0 for the 25 year period and 2.4 to 1.0 for the 100 year period. Considering the net benefits in relation to the required additional investment, the annual returns are estimated at 15 percent.

SUMMARY

In summary, this report on proposed drainage and reclamation in the Eastern Irrigation District shows that the capital costs would approximate \$8,648,120.00. Based on the estimated original classification in the Eastern Irrigation District, this is \$36.39 per acre. On the same basis, costs in the four selected study areas range from \$23.36 to \$48.42 per acre.

Tangible benefits considered in this report accrue to agricultural production and the Irrigation District. 58,140 acres can be returned to 90% production in 4 years. The additional acreage will increase gross agricultural production by \$2,088,389 per annum. Further benefits to production will accrue from increased drainage facilities in the entire project; i.e., areas other than the 58,140 affected by high ground water and salts. Direct increased water rate charges payable to the Eastern Irrigation District will be \$110,375.00 annually, while operation and maintenance, and replacement costs are estimated at \$270,931.00 annually.

Many primary, secondary and tertiary benefits could not be measured due to the nature of the study. The most important are described as follows:

1. Increased capital value of agricultural farm units.
2. More efficient field operations at the farm level.
3. Simplified weed control on borrow pits, canals and waste areas.
4. Reduced road maintenance costs due to improved surface drainage and lower ground water levels.
5. Reassessments of presently non-irrigable land will bring increased revenue to the country.
6. Well drained rural communities have lower farm and municipal mosquito control costs.
7. Business community benefits from increased cash sales.
8. Increased production reflected in higher tax returns at all levels.

We respectfully submit that the evidence presented in this report strongly supports the proposition that complete drainage programmes are economically feasible.

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MAP OF
LOCATION OF REPRESENTATIVE
DRAINAGE STUDY AREAS

